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Data Set Description:

PI:	Scott Stierle and Germar Bernhard
Instrument:	SUV-100 spectroradiometer (all sites) and SUV-150B spectroradiometer (Summit)
Site(s):	Arrival Heights, Antarctica (77.83° S, 166.67° E, 190 m)
	Palmer Station, Antarctica (64.77° S, 64.05° W, 21 m)
	Amundsen Scott South Pole Station, Antarctica (90° S, 2835m)
	Ushuaia, Argentina (54.82° S, 68.32° W, 30 m) – decommissioned November 2008
	Barrow, Alaska (71.32° N, 156.68° W, 8m) – decommissioned July 2016
	Summit, Greenland (72.58° N, 38.45° W, 3202 m) – decommissioned August 2017

Measurement Quantities:

Spectral irradiance on a horizontal surface (cosine weighted) between 280 and 600 nm.
Spectra are corrected for the instrument's cosine error; spectrally aligned against a reference solar spectrum by means of a Fraunhofer-line correlation algorithm; normalized to a wavelength-independent bandwidth of 1.0 nm (SUV-100) or 0.63 nm (SUV-150B); and re-gridded to a uniform wavelength scale.

The data summaries of the NDACC database include the following:

1. 290-315 nm UVB (W m-2)
2. 315-400 nm UVA (W m-2)
3. Erythemal UV (W m-2)
4. DNA-weighted UV (W m-2)
5. Generalized Plant (W m-2)
6. Vitamin D production (W m-2)

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Reference Articles:

Only a subset of publications is provided below. A complete list of references is available at http://uv.biospherical.com/references.asp.

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Instrument Description:

Data are collected by spectroradiometers of type SUV-100 and SUV-150B from Biospherical Instruments Inc. Instruments are based on a temperature-stabilized, scanning, double-monochromator that is coupled to a photomultiplier tube (PMT) detector. The SUV-100 uses a diffuser as irradiance collector that is coupled via a relay lens to the monochromator. The SUV-150B employs an integrating sphere that is coupled via a quartz-fiber bundle. Both systems have internal mercury-vapor and tungsten-halogen lamps for tracking the instrument's stability. Spectra of these lamps are typically recorded once per day. Spectra of global spectral irradiance from 280 to 605 nm are measured every 15 minutes (60 minutes before 1997) when the solar zenith angle is smaller than 92°. The bandwidth of the SUV-100 is approximately 1.0 nm full width at half maximum (FWHM). The bandwidth of the SUV-150B is 0.63 nm FWHM. More details on the instruments and their specifications can be found in Chapter 2 of Network Operations Reports [e.g., Bernhard et al., 2008a].

SUV-100 and SUV-150B instruments meet NDACC (formerly NDSC) specifications for UV instruments [McKenzie et al., 1997] with the following exceptions:

SUV-100:

1 - The cosine-error of SUV-100 spectroradiometers is on average -8.5% at 60 degree, and -7% to isotropic radiation, which is outside the NDACC target specification of < +/- 5%. The cosine-error correction that is part of data processing limits the associated uncertainty of corrected solar data to < +/- 5% (+/- 2 σ) for wavelengths smaller than 400 nm and solar zenith angles smaller than 80 degree. The effectiveness of the cosine error correction algorithm has been demonstrated via comparison with a NDACC-certified instrument [Bernhard et al., 2008c].

2 - The expanded (k=2) wavelength uncertainty of most Version 2 spectra is 0.08 nm at 300 nm and about 0.06 nm at wavelength in the UV-A and visible. These values are slightly outside the NDACC target specification of < +/- 0.05 nm. Wavelength shifts for every spectrum are documented, and data with wavelength shifts larger than +/- 0.1 nm are flagged.

3 - The detection threshold (or noise equivalent irradiance) of SUV-100 measurements typically varies between $4 \cdot 10^{-6}$ and 10^{-5} W/(m^2 nm), which exceeds the NDACC target specification of 10^{-6} nm.

4 - Only global irradiance is being measured. Diffuse measurements are possible with the help of a shading disk positioned manually, but this is not done operationally.

SUV-150B:

1 - The detection threshold (or noise equivalent irradiance) of SUV-150B measurements from the period August 2004 - May 2005 was $7 \cdot 10^{-6}$ W/(m^2 nm). Later data have a detection threshold of 10^{-6} W/(m^2 nm) and meet NDACC specifications.

2 - Only global irradiance is being measured. Diffuse measurements are possible with the help of a shading disk positioned manually, but this is not done operationally.

Algorithm Description:

Data are recorded in a binary format and are converted to ASCII using a MS Visual Basic program. This program also applies wavelength and irradiance calibrations to the data taking into account daily scans of the internal mercury and halogen lamps, and the bi-weekly scans of 200-Watt irradiance standards. These lamps are traceable to the NIST/FASCAL irradiance scale of 1990. Data are quality controlled and made available to the public as "Version 0 data of the UVSIMN." The final step is to convert "Version 0 data" to "Version 2 data," which are corrected for the instrument's cosine error; spectrally aligned against a reference solar spectrum by means of a Fraunhofer-line correlation algorithm; normalized to a wavelength-independent bandwidth of 1.0 nm (SUV-100) or 0.63 nm (SUV-150B); and re-gridded to a uniform wavelength scale. Version 2 data have to pass a second rigorous quality control procedure before they are disseminated to the public. Data submitted to the NDACC database are based on Version 2 data.

Quality control steps include: daily system checks and cleaning for entrance optics; calibration with 200-Watt lamps every two weeks; annual review of the traceability chain of calibration standards and re-calibration if necessary; comparison of internal instrument parameters with target values; check of wavelength accuracy by means of Fraunhofer-line correlation [Bernhard et al., 2004]; comparison of SUV data with measurements of GUV multi-filter radiometers; comparison of SUV data with modeling results; comparison with historical data for detecting possible drifts in calibrations; and documentation of quality control results in Operations Reports and metadata files.

The procedure of converting binary data to Version 0 data is described in Chapter 4 of Network Operation Reports [e.g., Bernhard et al., 2008a]. Results on Quality Control of Version 0 data, including review of irradiance standards, are provided in Chapter 5 of those reports. The procedure of converting Version 0 to Version 2 is described in the technical supplement by Bernhard et al. [2004].

Precision/Accuracy of Instrument:

A comprehensive uncertainty budget for Version 2 data of South Pole is provided by Bernhard et al. [2004]. Uncertainty budgets for other sites are available at the web site http://uv.biospherical.com/Version2/Version2.asp. Expanded relative uncertainties (coverage factor $k = 2$, equal to $+/- 2\sigma$) depend on wavelength and solar zenith angle, amongst other factors, and vary between 4.6% and 13.4% (maximum uncertainty at 600 nm). Expanded uncertainties for spectral irradiance at 310 nm range between 6.2% and 6.4% and are dominated by uncertainties related to calibration, stability, and wavelength errors. At larger wavelengths, the greatest uncertainty arises from insufficient knowledge of the contribution of direct irradiance to global irradiance, which is required for the cosine-error correction procedure. Expanded uncertainties for spectral irradiance at 600 nm range between 4.6% for overcast conditions and 13.4% for periods with variable cloudiness. Expanded uncertainties for erythemal irradiance and the UV Index vary between 5.8% and 6.4%, and are only slightly influenced by sky condition. The expanded wavelength uncertainty of Version 2 spectra is 0.08 nm at 300 nm and about 0.06 nm at wavelength in the UV-A and visible.

Instrument History:

Arrival Heights
- Established: March 1988
- Upgrade of cosine-collector: February 2000
- Comparison with NDACC instr.: November 2006 - January 2007 [Bernhard et al., 2008c]
- Transfer of responsibility: ~2010 (from Biospherical Instruments / PI Bernhard to NOAA/ESR/GMD / PI Disterhoft)
- Transfer of responsibility: 2020 (from PI Disterhoft to PI Stierle)

Palmer Station
- Established: May 1988
- Relocation: March 1993 (from Clean Air/VLF to T-5 building)
- Upgrade of cosine-collector: March 2000
- Relocation: May 2006 (from T-5 to "Terra Lab" building)
- Transfer of responsibility: ~2010 (from Biospherical Instruments / PI Bernhard to NOAA/ESR/GMD / PI Disterhoft)
- Transfer of responsibility: 2020 (from PI Disterhoft to PI Stierle)

South Pole
- established: February 1988
- Relocation: January 1991 (from top of Clean Air Facility to enclosure within Clean Air Facility)
- Relocation: January 1997 (from Clean Air Facility to Atmospheric Research Observatory)
- Upgrade of cosine-collector: February 2000
- Transfer of responsibility: ~2010 (from Biospherical Instruments / PI Bernhard to NOAA/ESR/GMD / PI Disterhoft)
- Transfer of responsibility: 2020 (from PI Disterhoft to PI Stierle)

Ushuaia
- Established: November 1988
- Upgrade of cosine-collector: June 2000
- Decommissioned: November 2008

Barrow
- Established: December 1990
- Replacement cosine-collector: December 1993
- Upgrade of cosine-collector: January 2001
- Decommissioned: July 2016

Summit
- Comparison with NDACC instr.: June 2003 [Wuttke et al., 2006]
- Established: August 2004
- Relocation of host building: June/July 2005

- Upgrade integrating sphere: August 2005
- Relocation of host building: June 2009
- Relocation of host building: May 2012
- Relocation of host building: July 2013
- Increase of collector height July 2015 (including installation of a longer quartz fiber)
- Decommissioned: August 2017